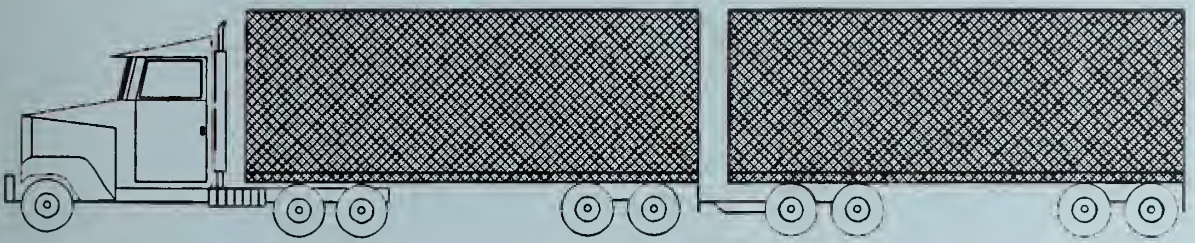
S
388.344
T6ET
1992

MONTANA DEPARTMENT OF TRANSPORTATION



EFFECTS OF TWIN 45s AS TURNPIKE DOUBLES ON MONTANA HIGHWAYS

STATE DOCUMENTS COLL
OCT 0 2004
MONTANA STATE LIB
1515 E. 6

Prepared by:

Planning and Programming Office
Dec., 1992

Montana State Library
3 0864 1003 1359 5

MONTANA DEPARTMENT
OF
TRANSPORTATION

EFFECTS OF TWIN 45S AS TURNPIKE DOUBLES ON MONTANA HIGHWAYS

DECEMBER, 1992

Submitted by:
Montana Department of Transportation
Multi-modal Transportation Planning
2701 Prospect Avenue
Helena, MT 59620

Digitized by the Internet Archive
in 2013

http://archive.org/details/effectsoftwin45s00mont

TABLE OF CONTENTS

Introduction....................................1

Objective.......................................1

The Twin 45 Foot Turnpike Double................1

Interchange Impacts.............................1

Terminal Positions to Interchanges..............3

Impact on Highway Surfaces of Permitting Twin 45s as Turnpike Doubles..............................4

   Assumptions..................................5

   Projected Surface Damage, Taxes, and Difference...5-7

Safety..7

Summary...8

Attachment 1 - Typical Montana Interchanges.....9

Attachments 2 thru 5 - Swept Paths at Montana interchanges and intersections................10-13

List and Map of Problem Interchanges for Turnpike Doubles..............................14-19

Examples of Off-Tracking Damage.............21-24

INTRODUCTION

Trucking is a major and multifaceted element of Montana's freight transportation system. Industries essential to Montana's economic base, including agriculture, mining, construction, and timber, rely on trucking for the conveyance of goods and materials. In many of Montana's rural areas, trucking has become increasingly important due to loss of railroad service. Montana recognizes the socio-economic impact of trucking and continually works toward meeting the needs of the trucking industry. However, as allowable truck sizes have increased, so have the related obstacles.

In response to recent questions that deal with allowing twin 45 foot trailers as turnpike doubles (TDs) to travel on Montana's interstate system and to freight terminals along the system, the Montana Department of Transportation (MDT) Multi-modal Transportation Planning Office has conducted a study to determine the amount of pavement surface damage, and other extraneous damage, these trucks would cause.

OBJECTIVE

The objective of this report is to present the information accumulated during the study and provide projected costs resulting from surface damage and other extraneous damage, such as off-tracking encroachments from the use of twin 45s as TDs.

THE TWIN 45 FOOT TURNPIKE DOUBLE

The twin 45 TD is a tractor with two 45 foot trailers. It consists of nine axles, with three on the tractor and two on the back of the first trailer. The front and back of the second trailer each have two axles. Currently, turnpike doubles not exceeding 81 feet in trailer length travel all state systems. However, the volume is not significant (approximately one-tenth of a percent). If the combined tractor and trailer length exceeds 95 feet the turnpike double is restricted to the interstate system.

The legal weight allowed in Montana without a permit is 80,000 pounds gross for any large truck. It is conceivable, but not likely, that a twin 45 TD with a permit could carry as much as 128,000 pounds.

INTERCHANGE IMPACTS

The MDT Traffic Engineering Section has reviewed all 224 interchanges on the Interstate system in Montana, regarding the possible impacts of the TD truck.

Of the 224 interchanges, 14 have been found to be adequate as they now exist. These are "loop" type interchanges with no ramp terminal intersections (see attachment 1, figure 2). These do not include interchanges with a partial cloverleaf and ramp intersection.

An additional 82 interchanges are in rural settings with no services or junctions with numbered routes. These were regarded as having no significance in this study.

There are 108 interchanges noted as being route junctions or possible areas of TD use. Impacts were assessed for these interchanges. Similarly, 20 interchanges in urban areas were evaluated.

The study was limited to the physical impacts to interchange ramp terminal areas created by the off-tracking characteristics of the TD. Sixty percent of the interchanges studied involved an off-tracking encroachment in excess of 15 feet (see attachments 2 and 3).

In most cases damage from off-tracking encroachment occurs when a TD is making a right turn. The TD encroaches, but usually does not cause structural damage, when it's making a left turn (see attachments 4 and 5).

A sample of interchanges was selected at random to represent both rural and urban conditions and the impacts of the turning TDs were evaluated. The items involved in roadway improvements necessary to upgrade rural interchanges to accommodate the TDs are as follows:

1. Surfacing
2. Embankment
3. Drainage
4. Guardrail
5. Signing and Striping
6. Landscape
7. Cattle Guards
8. Mobilization
9. Traffic Control

In the urban interchanges studied, these additional items are affected:

1. Median Curb
2. Curb and Gutter
3. Street Excavation
4. Structure Widening
5. Lighting
   (Cattle guards are not included in urban interchanges.)

The average cost for upgrading and improving both ramp terminal areas of a rural interchange (diamond or conventional ramp) and making it accessible to TDs is $55,000.00 (see attachment 1, figure 1).

The average cost for upgrading and improving both ramp terminal areas of an urban interchange (diamond or conventional ramp) is $65,000.00 (see attachment 1, figure 1).

Estimates of costs to improve these interchanges are shown below. These estimates do not include right-of-way costs. In most rural locations, the required improvements can be made within existing right-of-way. In urban areas, it is likely that additional right-of-way will be needed.

Estimate Summary

	Cost to Improve
108 Rural Interchanges at $55,000	$5,940,000
20 Urban Interchanges at $65,000	$1,300,000
82 Rural Interchanges w/no services	-0-
14 Interchanges w/no impacts	-0-
224 Total Interchanges	$7,240,000

TERMINAL POSITIONS TO INTERCHANGES

This area of the study is virtually impossible to complete. The Department was unable to identify carriers that would definitely operate TDs given the opportunity. Sending a questionnaire was considered, but was determined to be too costly because a rate of return of only 10 percent was anticipated. Additionally, access routes are practically unlimited because of the number of possible locations and the uncertainty of future TD operations.

Without a doubt, the operation of a TD from the interstate to a terminal could be the most difficult aspect of TD operation. Current law for triple combinations, which are a significantly different configuration than the TD, allows access in a two mile radius of the interstate. State approval is not required to operate triples in this two mile radius. However, if a triple operator elects to operate outside the two mile radius, specific route approval must be granted by the Administrator of the Motor Carrier Services Division. This approval is contingent on recommendations by local authorities. If TD operations were to be allowed in Montana, the Department would recommend that the access

provisions for TDs be expressly limited and not as broad as access granted to triples. Approval from the Department should be required for each access request and route to each terminal. This requirement would alleviate any safety concerns caused by the larger turning radius of the TD.

In the 1991 Legislative Session the trucking industry stated it was willing to use designated staging areas if TDs were allowed on the interstate system. Since there exists concern about the operation of these larger units in our cities, this approach offered a reasonable compromise. If this option were accepted in conjunction with specific routes the Department could effectively regulate TD access.

THE IMPACT ON HIGHWAY SURFACES OF PERMITTING TWIN 45S AS TURNPIKE DOUBLES

If TDs are allowed to operate in Montana they would be restricted to the interstate system by existing regulation. Earlier in this report we discussed the ability of the interchanges on the system to accommodate TDs. This study revealed that only about 7% of the existing interchanges could accommodate TDs without any modification. Another 57% of the interchanges would require changes while the remaining interchanges would not need work since they are not expected to provide services to TDs. The Department estimates this work would require a one time overhaul of the affected interchanges at a cost of $7,240,000.

Axle weight is a major pavement damage factor. Numerous studies have shown that as axle weight increases the damage to the pavement increases in the form of rutting and pavement fatigue. TDs offer reduced axle weight and, may offer a more cost-beneficial method of motor carrier transportation. However, because there is insufficient data to make assumptions on the extent of TD usage, it is not possible to determine if savings in pavement preservation attributed to TD use would offset the cost of interchange modification.

Determining the impact trucks have on highway surfaces includes: 1) making an estimation of the number of trucks using the route being studied; 2) an estimation of the number of miles the trucks are traveling; 3) an estimation of the equivalent single axle loads (ESALs) a truck transmits to the pavement; 4) the numbers of days per year the truck is in operation and; 5) a damage factor. The damage factor was determined by the Montana State University Department of Civil and Agricultural Engineering.

Assumptions:

1. The average trucker travels 500 miles per day. (50 MPH X 10 hours, Hudson - MCS).

2. Number of TDs traveling through Montana per day is 30, or 10,950 TD-days per year. (Hudson - MCS).

3. The estimated average weight carried by a TD with a permit is 91,000 pounds. This would create an ESAL of .791. The 91,000 pounds was determined by averaging the estimated loaded TD weight and the estimated empty TD weight. These estimates were derived by researching weigh station records for turnpike doubles currently using the system.

PROJECTED TOTAL SURFACE DAMAGE

Using damage factor for interstate highways:

500.00 miles
X 30.00 TDs per day
X 365.00 days
X .791 ESAL's
X .16 damage factor
$692,916.00 per year

State and federal taxes and fees, and the fund they are directed to: (Eddlemon and Ala - MCS)

$15,147.50	Federal and state diesel tax combined (assuming five miles per gallon).
3,028.50	Weight fee (MDT)
100.00	Overweight fee (MDT)
75.00	Oversize fee (MDT)
25.25	Registration fee (General)
4.00	Identification fees (MDT)
550.00	Heavy vehicle use tax (IRS)
$18,930.25	**per truck per year**

$18,930.25
X 30.00 Trucks
$567,907.50 per year

Difference between taxes/fees and total damage cost:

$567,907.50 (Taxes and fees)
-$692,916.00 (total damage cost)
-$125,008.50

PROJECTED SURFACE DAMAGE TO STATE OF MONTANA

Using damage factor for interstate highways:

	500.00	miles
X	30.00	TDs per day
X	365.00	days
X	.791	ESAL's
X	.25	State share of damage (construction and maintenance)
X	.16	Damage factor
	$173,229.00	**per year**

State truck taxes and fees, and the fund they are directed to: (Eddlemon - MCS)

$7,811.00	State diesel tax (assuming five miles per gallon)-(MDT)
$3,028.50	Weight fee (MDT)
100.00	Overweight fee (MDT)
75.00	Oversize fee (MDT)
25.25	Registration fee (General)
4.00	Identification fees (MDT)

$11,043.75	Total fees
X 30	Trucks
$331,312.50	Taxes and fees paid per year.

Difference between state taxes/fees and damage cost:

$331,312.50 (Taxes and fees)
-$173,229.00 (state damage cost)
$158,091.00

PROJECTED SURFACE DAMAGE TO FEDERAL GOVERNMENT

Using damage factor for interstate highways:

	500.00	miles
X	30.00	TDs per day
X	365.00	days
X	.791	ESAL's
X	.75	Federal share of damage (construction)
X	.16	Damage factor
	$519,687.00	**per year**

Federal truck taxes and fees, and the fund they are directed to: (Ala - MCS)

$7,336.50	Federal diesel tax (assuming five miles per gallon)
550.00	Heavy vehicle use tax (IRS)
$7,886.50	Total fees
X 30	Trucks
$236,595.00	Taxes and fees paid per year.

Difference between federal taxes/fees and damage cost:

$236,595.00	(Taxes and fees)
-$519,687.00	(federal damage cost)
-$283,092.00	

The .791 ESAL for the TD is less than the average ESAL for a Rocky Mountain double (1.825), triple trailer (2.918) and single trailer (1.527) carrying their respective average operating weights.

This difference in ESAL is due to the axle configuration and weight distribution. In the case of the triple trailer the operating weight is displaced over three trailers rather than two, but the triple trailer has six single axles rather than four tandem axles. Single axles, although they may be carrying less weight, can inflict considerably higher amounts of pavement damage.

Comparing the TD to the single 53 foot trailer, the increased weight per trailer causes a radical increase in ESAL. A single trailer operates at maximum axle limits, whereas TDs operate at lower axle weights causing lower ESAL's. Although the weight might only go up by 50 percent, the ESAL could go up by nearly 200 percent due to the exponential effect of weight on axles.

SAFETY

Triple trailer operations have amassed a very impressive safety record since being allowed in Montana. Original fears that these large trucks increase accidents and truck safety problems have not been proven. Additionally, triples are allowed under a strict set of permit conditions which promote the safest possible operation. Under these guidelines, and a few additional access restrictions, TD operations could prove to be an effective, efficient method of motor carrier transportation. In any event TDs could be allowed to operate for a trial period (exactly like the

trial period before triples were implemented), before final approval. Actual operation would provide the opportunity to study safety implications and to ascertain the interest in operating these special vehicle combinations.

SUMMARY

Responses to the 52nd Legislature's required study, as specified in section 4 of Senate Bill 0178/03, are as follows:

(A) There are a total of 224 interchanges in Montana. Of those, 128 would need modifications to accommodate the swept-path of the TD.

(B) The Department has found that the impact on highways (surface damage) of a single TD unit using Montana's interstate system is less than the effects of most single units of other truck configurations.

(C) Determining terminal positions is not feasible at this time. This is due to the high cost of mailing and the projected low response of a questionnaire.

(D) The concept of allowing TDs would require restricting them to the interstate system due to the size and off-tracking. This can be allowed only if upgrading to interchanges is done.

The Department has concluded that TDs could be permitted to run on Montana's interstate system since the safety and surface damage effects of a single TD unit using the system are less than the effects of most other single units. The use of TDs, however, would require a statewide upgrading of 128 interchanges or whichever interchanges TDs might be permitted to use. This modification is needed to accommodate the swept-path of the TD.

Typical Montana Interchanges

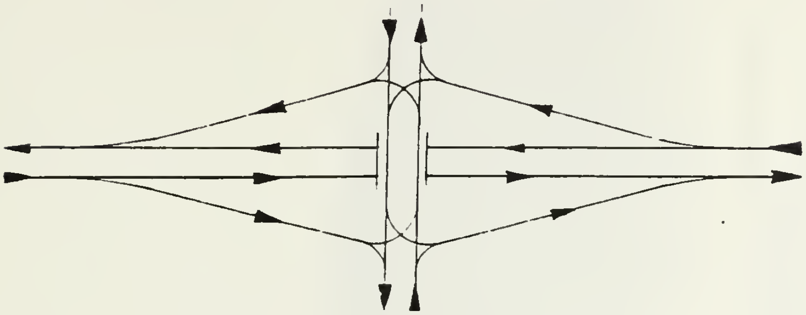


Figure 1. Diamond interchanges, conventional arrangements.

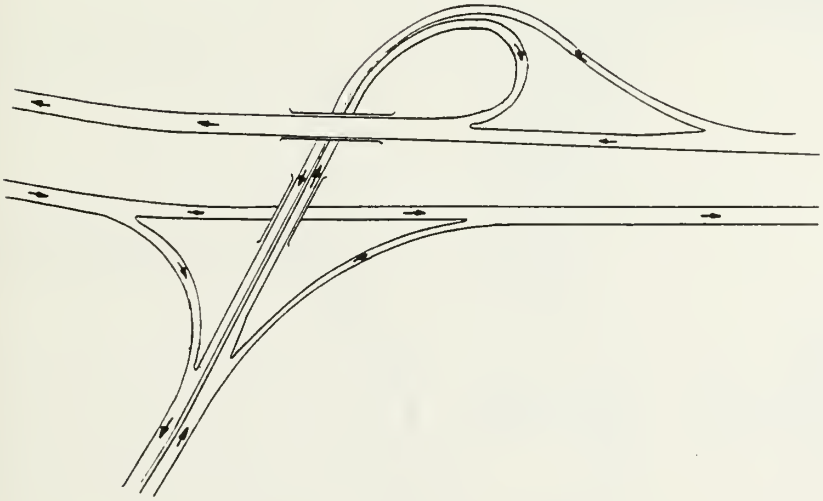
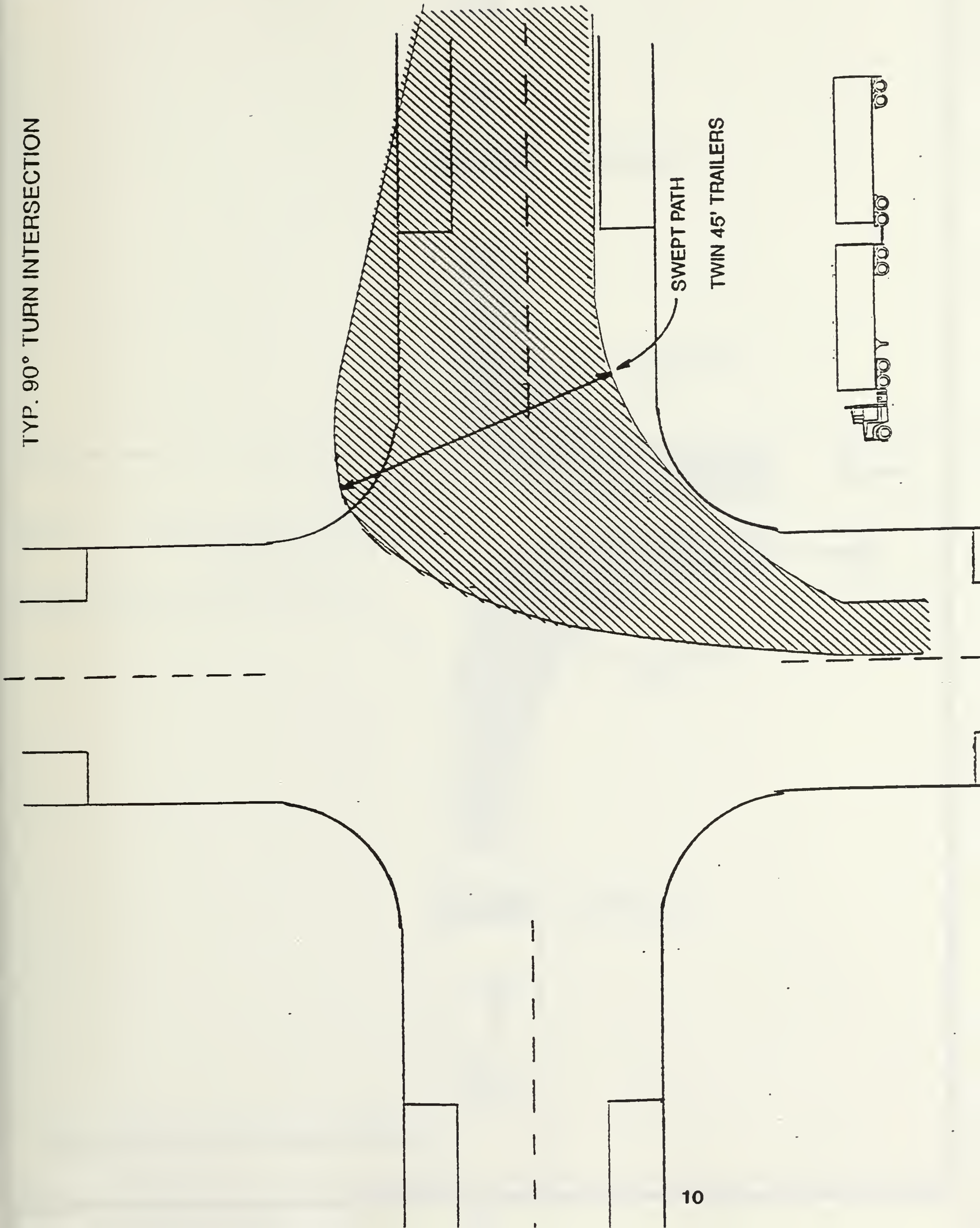


Figure 2. Three-leg interchange (T-type or trumpet).

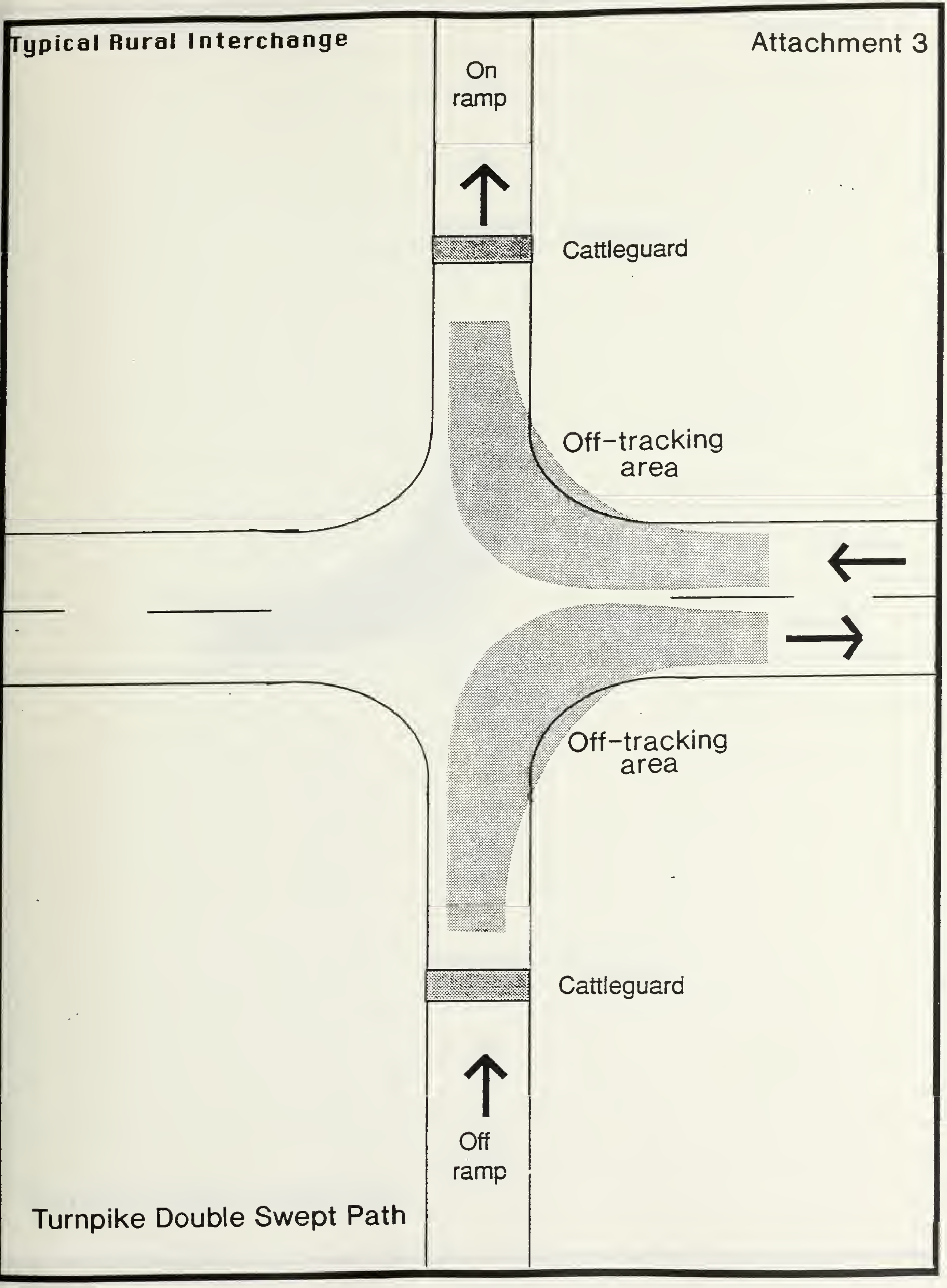
Attachment 2

TYP. 90° TURN INTERSECTION



Typical Rural Interchange

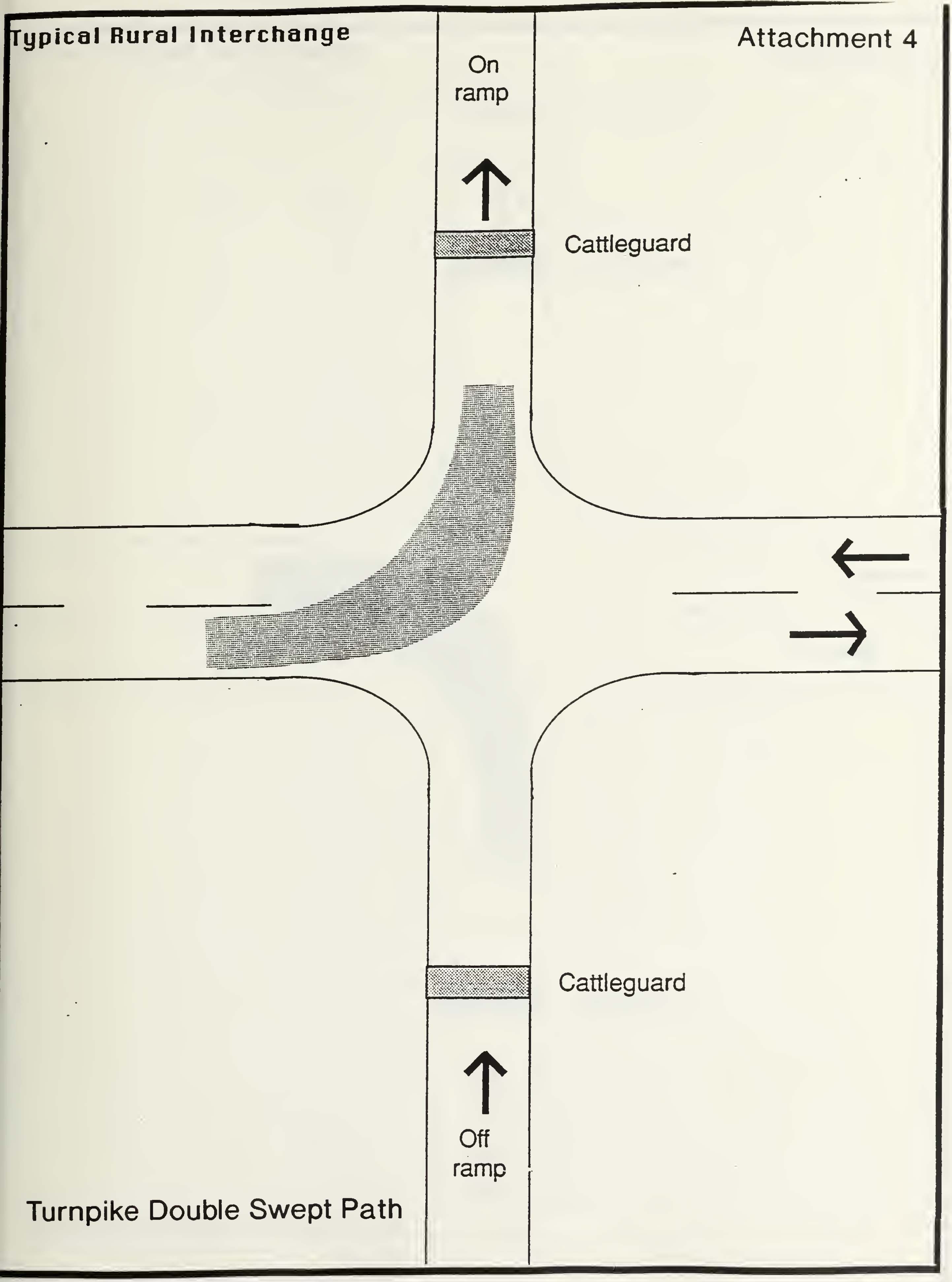
Attachment 3



Turnpike Double Swept Path

Typical Rural Interchange

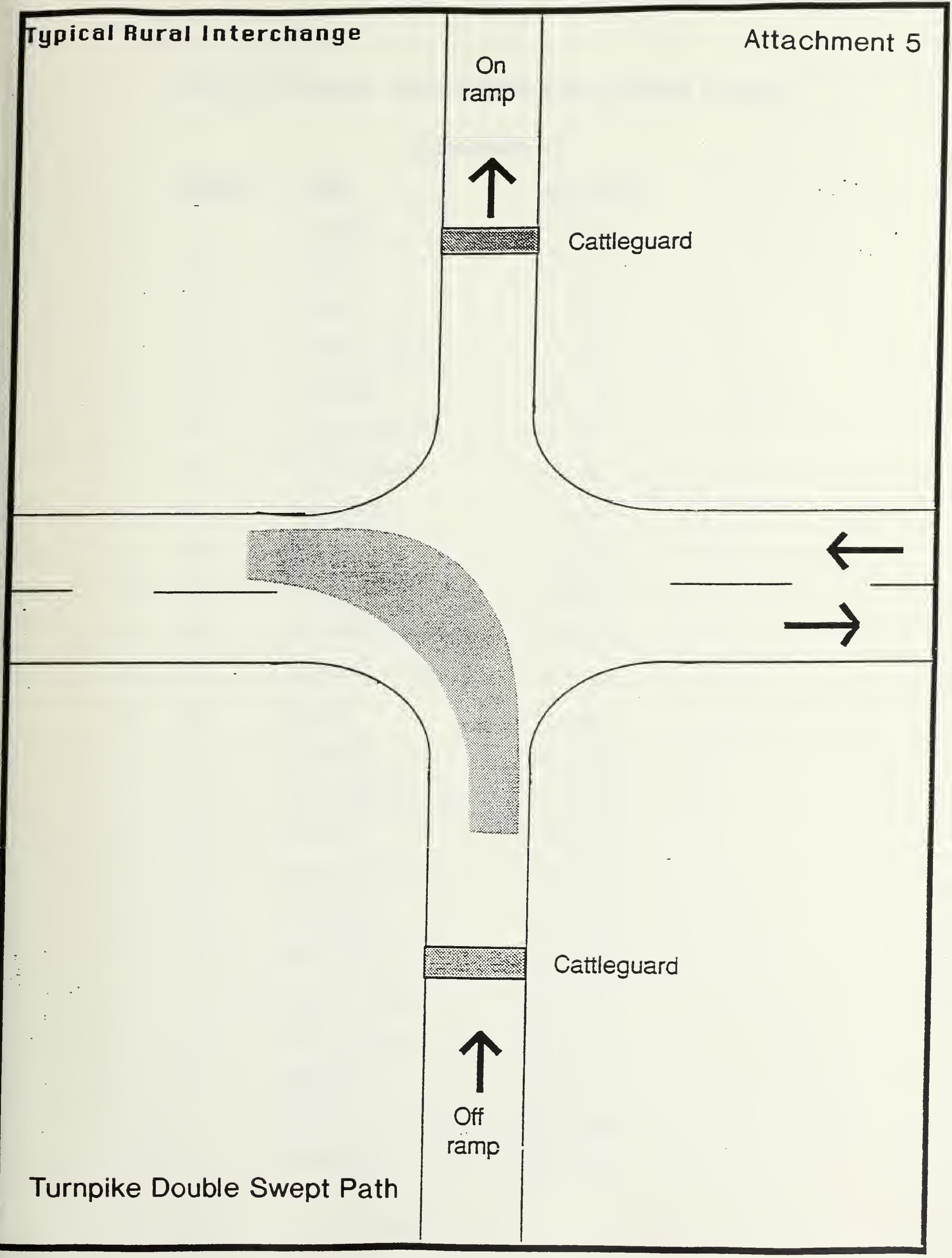
Attachment 4



Turnpike Double Swept Path

Attachment 5

Typical Rural Interchange



Turnpike Double Swept Path

LIST OF PROBLEM INTERCHANGES FOR TURNPIKE DOUBLES

INTERSTATE 15

	Number	Name	Milepost
1.	0	Monida	0.508
2.	15	Lima	15.170
3.	23	Dell	23.831
4.	44	Horse Prairie	44.466
5.	59	Jackson	59.711
6.	62	South Dillon	62.824
7.	85	Rock Creek	85.214
8.	93	Melrose	93.122
9.	102	Divide	102.487
10.	122	Rocker	122.423
11.	126	Montana Street	126.316
12.	127	Harrison Avenue	127.936
13.	156	Basin	156.911
14.	164	Boulder	164.920
15.	176	Jefferson City	176.109
16.	182	Clancy	182.116
17.	187	Montana City	187.707
18.	192	Capitol	192.148
19.	193	Cedar St.	193.316
20.	200	Lincoln Rd.	200.087
21.	226	Wolf Creek	226.764
22.	228	Augusta	228.566
23	234	Craig	234.216
24.	240	Dearborn	240.415

	No.	Name	Milepost
25.	244	Canyon	244.063
26.	247	Hardy Creek	247.326
27.	254	South Cascade	254.949
28.	256	North Cascade	256.483
29.	270	Ulm	270.425
30.	277	Gore Hill	277.802
31.	278	10th Ave. S.	278.976
32.	280	Central Avenue	280.563
33.	282	Emerson	282.535
34.	302	Power	302.610
35.	313	Dutton	313.248
36.	328	Brady	328.145
37.	335	Midway	335.516
38.	339	Conrad	339.361
39.	345	Ledger	345.254
40.	348	Valier	348.261
41.	363	West Shelby	363.488
42.	364	North Shelby	364.736
43.	379	Kevin	379.255
44.	389	Sunburst	389.810
45.	397	Sweetgrass	397.905

INTERSTATE 90

46.	10	Saltese	10.529
47.	16	Haugan	16.330
48.	18	DeBorgia	18.916
49.	33	St. Regis	33.407

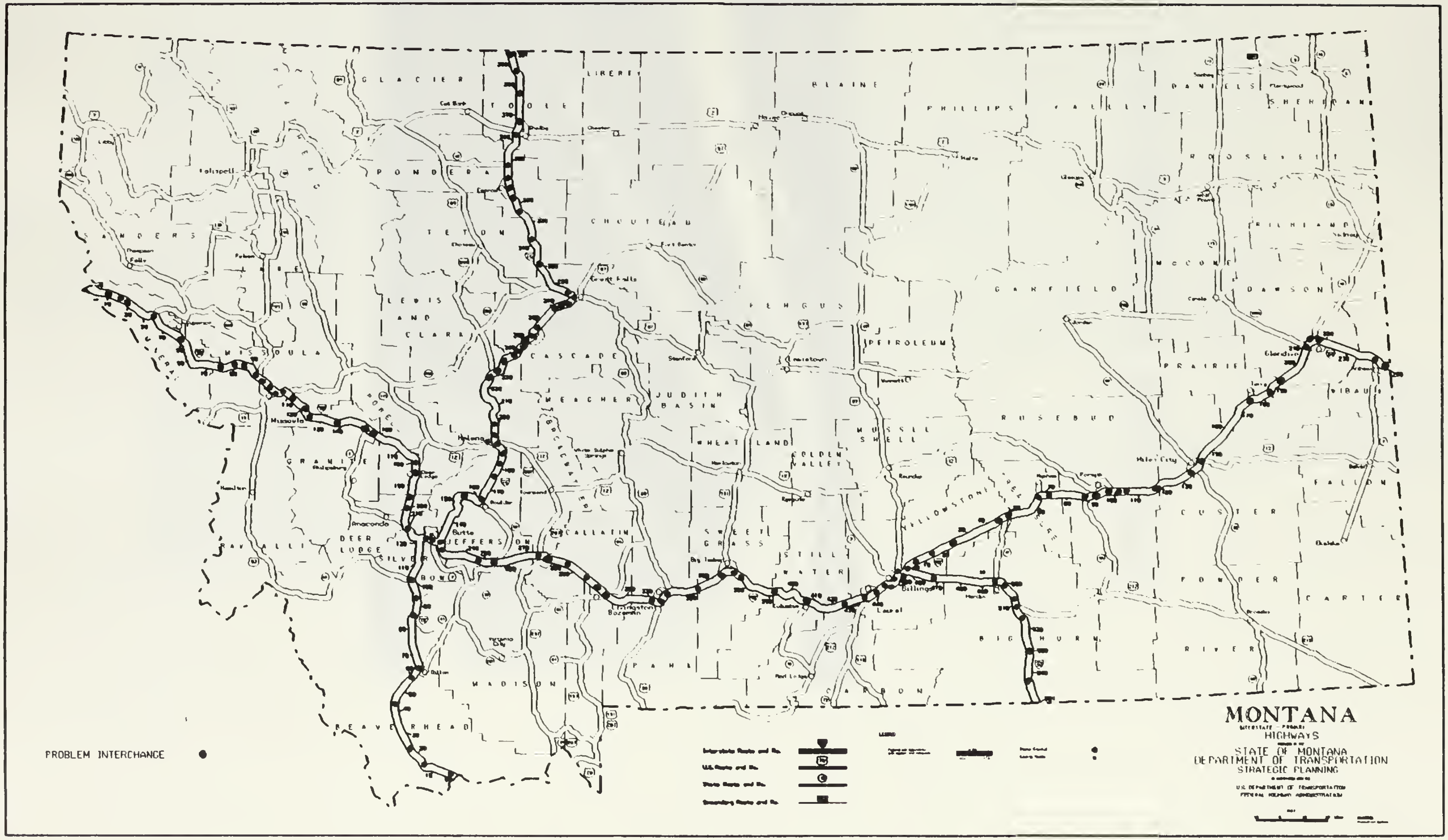
	No.	Name	Milepost
50.	47	Superior	47.550
51.	75	Alberton	75.163
52.	82	Nine Mile	82.623
53.	89	Frenchtown	89.753
54.	96	Desmet	96.343
55.	101	Reserve St.	101.708
56.	104	Orange St.	104.780
57.	105	Van Buren St.	105.633
58.	107	East Missoula	107.270
59.	113	Turah	113.886
60.	120	Clinton	120.993
61.	126	Rock Creek	126.039
62.	138	Bearmouth	138.085
63.	153	West Drummond	153.356
64.	154	East Drummond	154.280
65.	175	East Garrison	175.533
66.	184	North Deer Lodge	184.906
67.	197	Galen	197.560
68.	201	Warm Springs	201.549
69.	211	Gregson	211.864
70.	227	East Butte	227.455
71.	228	Continental Drive	228.635
72.	249	Whitehall	249.026
73.	256	Cardwell	256.293
74.	274	West Three Forks	274.791
75.	278	East Three Forks	278.336

	No.	**Name**	**Milepost**
76.	288	Manhattan	288.680
77.	298	Belgrade	298.279
78.	306	West Bozeman	306.879
79.	309	East Bozeman	309.370
80.	332	South Livingston	332.941
81.	337	East Livingston	337.877
82.	340	Mission	340.410
83.	354	Springdale	354.316
84.	367	West Big Timber	367.648
85.	370	East Big Timber	370.792
86.	378	Greycliff	378.044
87.	392	Reedpoint	392.117
88.	408	Columbus	408.903
89.	426	Park City	426.594
90.	434	Laurel	434.090
91.	437	Mossmain	437.479
92.	445	West Billings	445.964
93.	446	West Billings	446.158
94.	450	27th Street	450.095
95.	452	Lockwood	452.856
96.	455	Johnson Lane	455.307
97.	456	Pinehill	456.580
98.	469	Arrow Creek	469.753
99.	495	West Hardin	495.998
100.	497	East Hardin	497.595
101.	509	Crow Agency	509.231

	No.	Name	Milepost
102.	510	Custer Battlefield	510.887
103.	514	Garryowen	514.772
104.	530	Lodge Grass	530.677
105.	544	Wyola	544.007
		INTERSTATE 94	
106.	6	Huntley	6.207
107.	14	Ballantine	14.843
108.	23	Pompey's Pillar	23.262
109.	47	Custer	47.218
110.	49	Montana 47	49.551
111.	67	Hysham	67.975
112.	72	Sarpy Creek	72.033
113.	87	Colstrip	87.640
114.	93	West Forsyth	93.612
115.	95	East Forsyth	95.236
116.	103	West Rosebud	103.956
117.	106	East Rosebud	106.796
118.	117	Hathaway	117.778
119.	138	Broadus	138.330
120.	141	Baker	141.153
121.	176	Terry	176.489
122.	185	Fallon	185.480
123.	192	Bad Route Creek	192.604
124.	211	Circle	211.480
125.	213	Sidney	213.359
126.	215	East Glendive	215.437

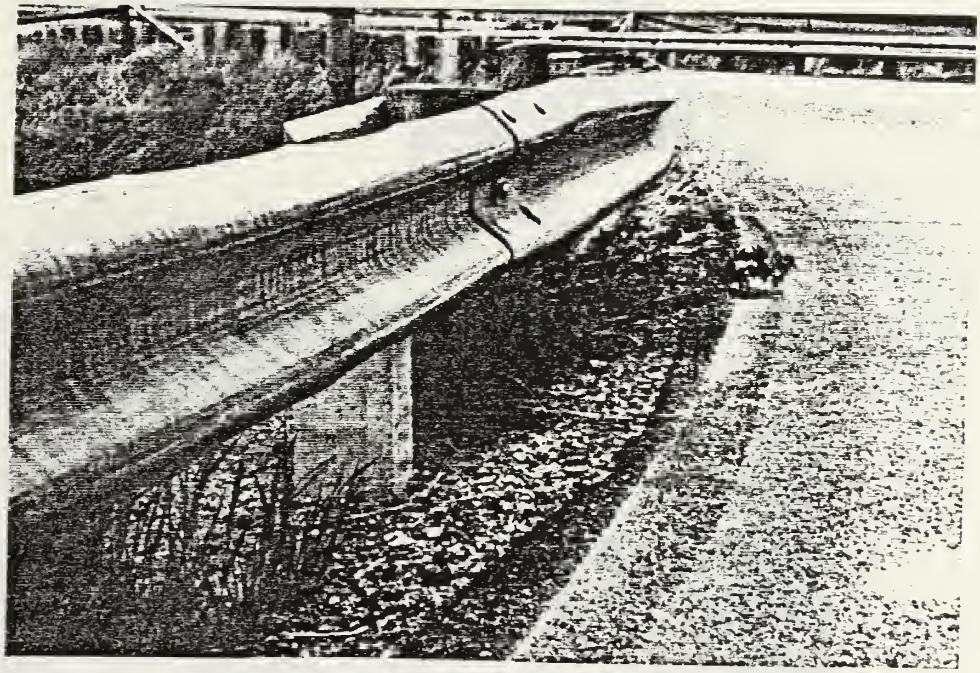
	No.	Name	Milepost
127.	241	West Wibaux	241.851
128.	242	East Wibaux	242.473

Map of Problem Interchanges for Turnpike Doubles

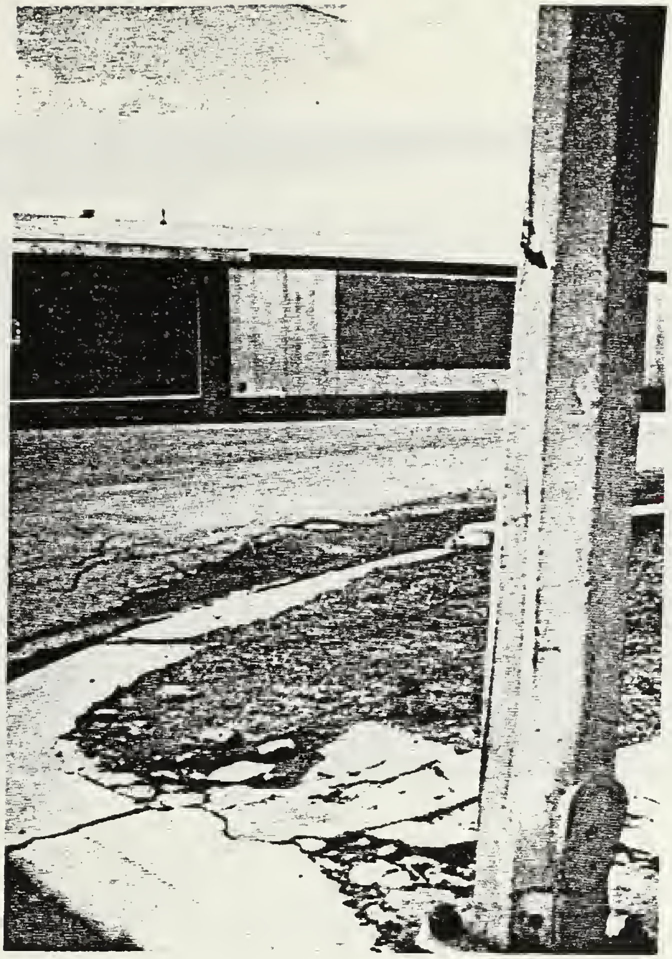


]

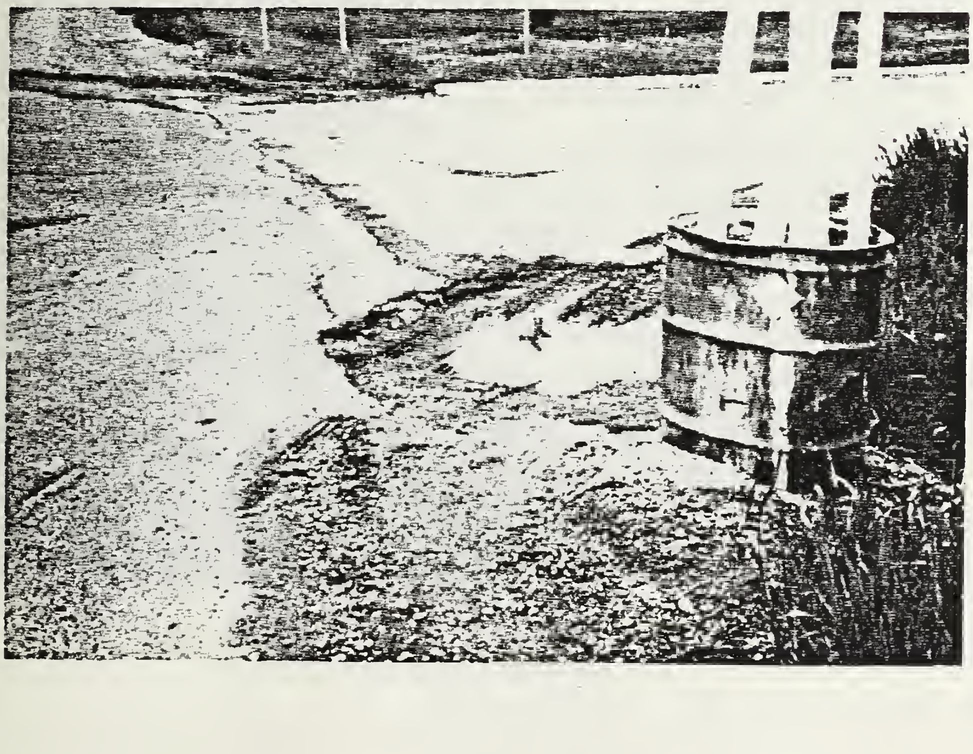
Off-tracking damages

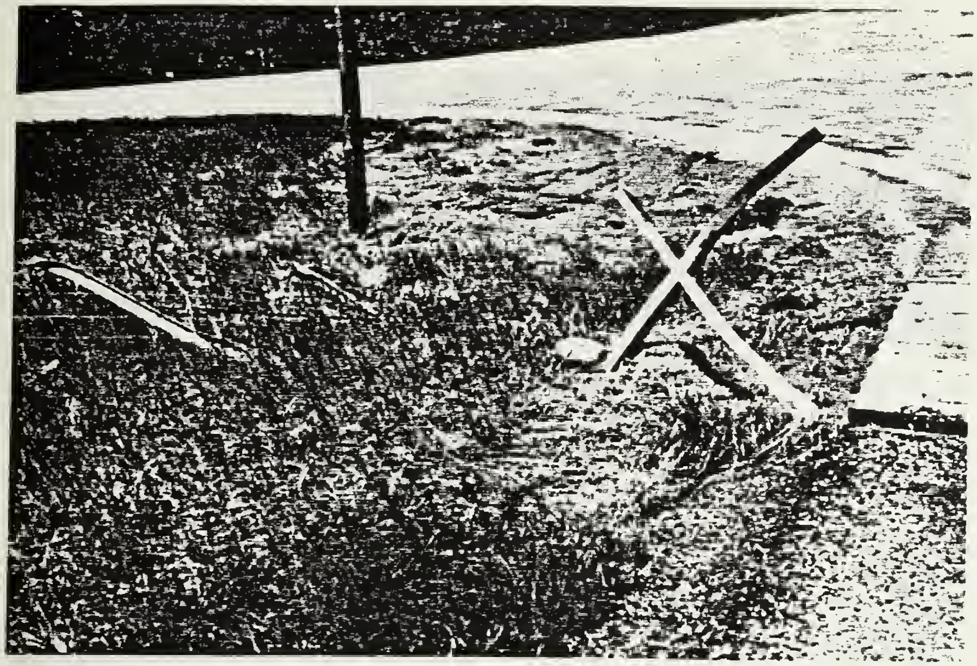


Interchange guardrail that has been damaged, replaced, and damaged again



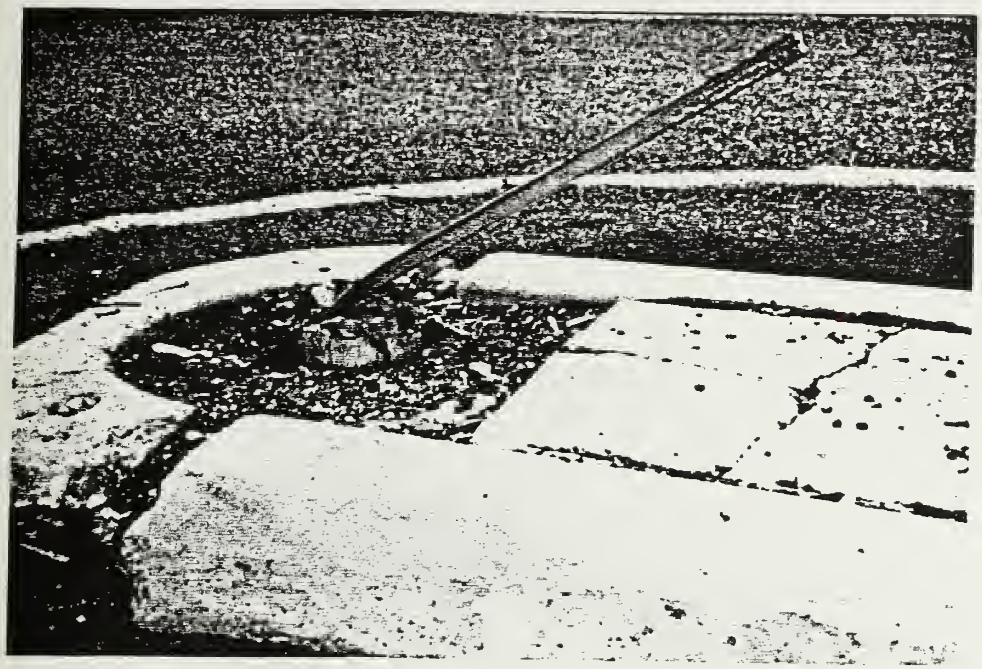
Curb and street light damage



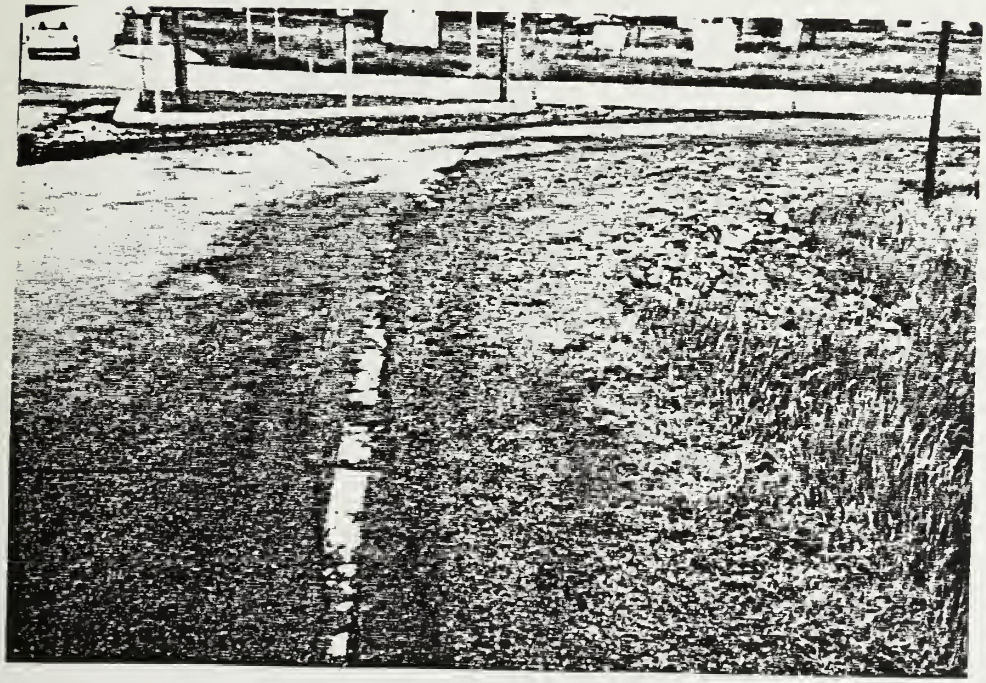


Cattleguard damage

Curb erosion



Median, reflector, and sign post damage



Pavement erosion

Two-hundred copies of this study
were produced at a cost of $1.28
per copy for a total cost of $225.